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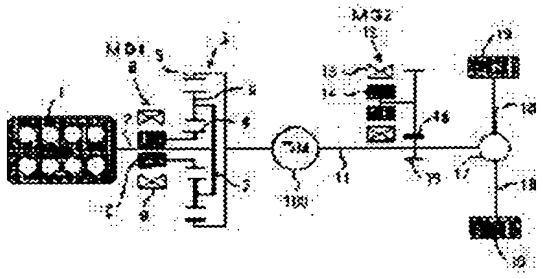
(54) HYBRID VEHICLE DRIVE STRUCTURE WITH TRANSMISSION

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent a second motor generator MG2 from being large and to obtain required axle torque characteristics against speed while properly maintaining the fuel consumption of an internal combustion engine, in hybrid vehicle drive structure in which an output shaft of the internal combustion engine is connected to a first motor generator and a wheel drive shaft through a power distribution mechanism, and a second motor generator is connected to the wheel drive shaft.

SOLUTION: Transmissions (100, 101, 102) are provided at least either at the middle of a wheel drive shaft or at the middle of the connection of the second motor generator to the wheel drive shaft.



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CLAIMS

[Claim(s)]
[Claim 1] Hybrid car actuation structure characterized by forming a change gear at least in one side in the middle of connection of said second motor generator to this wheel driving shaft in the middle of said wheel driving shaft in the hybrid car actuation structure where an internal combustion engine's output shaft was connected with the first motor generator and wheel driving shaft through the power partition system, and the second motor generator was connected with this wheel driving shaft.
[Claim 2] Said change gear is hybrid car actuation structure according to claim 1 characterized by being prepared in said internal combustion engine side in the middle of [section / of said second motor generator / connection] said wheel driving shaft.
[Claim 3] Said change gear is hybrid car actuation structure according to claim 1 characterized by forming said internal combustion engine in the far apart side in the middle of [section / of said second motor generator / connection] said wheel driving shaft.
[Claim 4] Said change gear is hybrid car actuation structure according to claim 1 to 3 characterized by including the astern stage.
[Claim 5] Hybrid car actuation structure according to claim 4 characterized by including a means to perform selection between the vehicle go-astern actuation by the astern stage of said change gear, and the vehicle go-astern actuation by accommodation of said power partition system.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the actuation structure of a hybrid car of driving a wheel with the combination of an internal combustion engine and a motor.
[0002]
[Description of the Prior Art] In recent years, the internal combustion engine and the hybrid car which a wheel drives with the combination of a motor are brought into the limelight under recognition of the importance of economization of increasingly increasing atmospheric environment maintenance and fuel sources. Although various modes will probably be possible about whether what we do with the actuation mode when driving the wheel of the automobile by which various rotational frequencies and the combination of driving torque are searched for with an internal combustion engine and a motor Drive an automobile only with an internal combustion engine chiefly originally, and the hybrid car in the field of an automobile Since it has left from replacing by electric actuation as long as a situation allows a part of actuation only by the conventional internal combustion engine, also although it is called a hybrid car, it is thought that actuation only by the internal combustion engine is naturally possible. The power shaft which connects the first motor generator to an internal combustion engine's crankshaft at a serial, and is driven with both an internal combustion engine, or both [either or] is constituted, respectively it connects with the flywheel starter gear and the sun gear of an epicyclic gear device, this power shaft and output shaft of the second motor generator are combined with JP,11-198669,A, and the hybrid car actuation structure of coming to connect a change gear with this is shown by using the carrier of an epicyclic gear device as an output shaft. According to this hybrid car actuation structure, even if it works only an internal combustion engine as a prime mover, the gear change function of a change gear is obtained and it can respond to the various operation modes for which an automobile is asked like the conventional internal combustion locomotive. This is considered to be one type reflecting the origin of the hybrid car like the above.
[0003] However, losing the change gear which absorbed with the motor the difference of the rotational frequency between the internal combustion engine output shaft resulting from the deviation between the rotational frequency pair driving torque for which a wheel is asked, and the rotational frequency pair driving torque acquired from an internal combustion engine, and an axle in differential at the opportunity to combine an internal combustion engine and a motor as a prime mover of an automobile, and was needed from the former between the internal combustion engine output shaft and the axle on the other hand at it was proposed by the same people as this applicant. Attached drawing 1 is the schematic diagram showing the actuation structure of such a hybrid car.
[0004] In drawing 1 , 1 is an internal combustion engine and is attached in the car body which is not shown in drawing. 2 is the output shaft (crankshaft). 3 is an epicyclic gear drive and, for 4, as for flywheel starter gear and 6, the sun gear and 5 are [a planetary pinion and 7] carriers. The crankshaft 2 is connected with the carrier 7. 8 is the first motor generator (MG1), and has with a coil 9 and a rotator 10, and the rotator 10 is connected with the sun gear 4. The coil 9 is supported from the car body. The end of a propeller shaft 11 is connected with flywheel starter gear 5. In this way, the epicyclic gear drive 3 constitutes the power partition system distributed to the propeller shaft 11 which outputs the internal combustion engine which appears in an internal combustion engine's output shaft 2 for the first motor generator 3 and wheel driving shaft. In the middle of the propeller shaft 11, the second motor generator (MG2) 12 is connected. It has the second motor generator 12 with a coil 13 and a rotator 14, and the coil 13 is supported from the car body. Although the connection of a rotator 14 to a propeller shaft 11 may be the structure of arbitration, it is made into the structure where the gearing 16 which is supported by the rotator 14 by the gearing 15 prepared in the propeller shaft 11, and rotates meshes, in the example of a graphic display. The other end of a propeller shaft 11 is connected with the axle 18 of a couple through differential equipment 17. The wheel 19 is

attached in each of an axle 18.
[0005] In the actuation structure of a graphic display, the revolution of a carrier 7 shall be the same as a revolution of a crankshaft 2, and shall express this rotational frequency with Nc now. Moreover, the revolution of a sun gear 4 shall be the same as a revolution of the first motor generator 8, and shall express this rotational frequency with Ns now. On the other hand, although the revolution of flywheel starter gear 5, a revolution of the second motor generator 12, and the revolution of a wheel 19 correspond mutually and it corresponds to the vehicle speed eventually, each number of revolutions changes with the ratios, the reduction gear ratios in differential equipment 17, and the diameters of a tire of a number of teeth between gearings 15 and 16. However, on behalf of the rotational frequency of these parts, it is now set to Nr at the rotational frequency of flywheel starter gear 5 for convenience here. When it does so, the relation between the rotational frequencies Nc, Ns, and Nr of the internal combustion engine and two motor generators MG1 and MG2 in the hybrid car actuation structure which combined an internal combustion engine and two motor generators like the graphic display with the epicyclic gear drive is expressed by the diagram shown in drawing 2 based on the principle of an epicyclic gear drive. rho is the number of teeth of a sun gear [as opposed to the number of teeth of flywheel starter gear in drawing] (rho< 1). Since Nc becomes settled at an engine rotational frequency and Nr becomes settled with the vehicle speed, Ns becomes settled as Ns=(1+1/rho) Nc-(1/rho) Nr by how of an engine rotational frequency and the vehicle speed.
[0006] On the other hand, when torque of a carrier, a sun gear, and flywheel starter gear is set to Tc, Ts, and Tr, these are Ts:Tc:Tr=rho / (1+rho) :1:1/(1+rho).
It balances mutually at a ** ratio, therefore when either of these 3 elements generates or absorbs torque, the exchange of torque is mutually performed again until the above-mentioned balance is realized.
[0007] In the hybrid car equipped with the actuation structure like ****, an internal combustion engine and actuation of MG1 and MG2 are controlled by the vehicle control device which is not shown in drawing based on train operation dispatching from an operator, and the operation condition of a vehicle. Namely, while a vehicle control device is equipped with a microcomputer and calculating the target vehicle speed and target wheel driving torque based on train operation dispatching from an operator, and the operation condition of the vehicle detected by various sensors The amount of generations of electrical energy required for charge of accumulation-of-electricity equipment is calculated. the current appearance which accumulation-of-electricity equipment is allowed based on the charge condition of accumulation-of-electricity equipment -- powerful -- it is -- It calculates in what kind of operational status including a pause an internal combustion engine should be operated based on these count results, and whether MG1 and MG2 should be operated in the state of what kind of electric condition or a generation of electrical energy, and an internal combustion engine and actuation of MG1 and MG2 are controlled based on the count result.
[0008]
[Problem(s) to be Solved by the Invention] According to the hybrid car actuation structure where an internal combustion engine's output shaft was connected with the first motor generator and wheel driving shaft through the power partition system, and the second motor generator was connected with this wheel driving shaft like the above Each value of the rotational frequency Nc of an internal combustion engine output shaft, and the rotational frequency Nr corresponding to the vehicle speed, and relative relation in the meantime as understood from drawing 2 Since it was substantially changeable by absorbing the change at the engine speed Ns of the first motor generator, in this hybrid car actuation structure, the change gear was made unnecessary until now. That is, it is dependent on accommodation of a power partition system, and can go astern irrespective of operation or a halt (Nc>=0) of carrying out an engine halt (Nc=0) to them, even if it is moving forward to carrying out engine operation (Nc> 0) even if it can change the relation between Nc and Nr freely and is under stop (Nr=0), and reverse (Nr> 0), or an engine (Nr<0).
[0009] However, the rotational frequency of MG2 has big constraint in the vehicle speed being influenced therefore how, and operating as a generator for charge of MG2 of accumulation-of-electricity equipment, since whenever [charge / of accumulation-of-electricity equipment] is unrelated to the vehicle speed once. Then, it will depend for charge of accumulation-of-electricity equipment on MG1 chiefly, and will depend for electric actuation of a wheel on reverse chiefly at MG2. Therefore, in the hybrid car actuation structure like the above which is not equipped with a change gear, in order to secure the vehicle performance which can acquire high wheel driving torque if needed also in a low vehicle speed field, **** MG 2 must be enlarged.
[0010] If the capacity property diagram of axle torque to the vehicle speed shows this, it will be as drawing 3 . Namely, if it is going to give the **** engine performance shown by Line A as marginal performance which covers a large vehicle speed region, operates the internal combustion engine of a vehicle with high fuel consumption, and

is moreover desired as vehicle speed pair axle torque engine performance of a vehicle now to a vehicle if it is not that with which the remainder must be chiefly compensated with MG2 and the vehicle speed pair axle torque engine performance provides Field C since the vehicle speed pair axle torque engine performance of the internal combustion engine which gets high fuel consumption becomes common mostly like Field B -- 7 -- it is -- ** Therefore, MG2 must be made [appropriate] large-sized so that high torque can be generated in low rotational speed.

[0011] However, if you examine drawing 3 , there arises a query whether the depth of Field C is too deep rather as contrasted with the depth of Field B. if this changes a viewpoint -- an internal combustion engine, the first, and the second -- a motor generator -- it is the problem of the relative balance of the magnitude of three original ******, especially the balance of the magnitude of an internal combustion engine and the second motor generator. This invention stems from this query and makes it the technical problem to improve the hybrid vehicle actuation structure like the above further about this point.

[0012]

[Means for Solving the Problem] As what solves this technical problem, this invention An internal combustion engine's output shaft is connected with the first motor generator and wheel driving shaft through a power partition system. In the hybrid car actuation structure where the second motor generator was connected with this wheel driving shaft, the hybrid car actuation structure characterized by forming a change gear at least in one side in the middle of connection of said second motor generator to this wheel driving shaft in the middle of said wheel driving shaft is proposed.

[0013] in addition -- a motor generator -- a word, although a means to have both the functions of a motor and a generator is pointed out As for the invention in this application, an internal combustion engine's output shaft is connected with the first motor generator and wheel driving shaft through a power partition system. If it puts in another way about the short-term vehicle actuation engine performance of the hybrid car actuation structure where the second motor generator was connected with this wheel driving shaft Since it is not related with the long-term vehicle actuation engine performance in which the correlation of the internal combustion engine actuation in hybrid actuation of a vehicle, electric actuation, and the self-charging effect over accumulation-of-electricity equipment involves As far as an operation and effectiveness of the invention in this application are concerned, all of the first and the second motor generator may be mere motors. as surely having already described as a vehicle driving gear which works -- the second motor generator -- chiefly -- as a motor -- not operating -- although the first motor generator needs to have the generation-of-electrical-energy function in order not to obtain (however, operating as a generator is also possible), therefore to constitute the vehicle driving gear which can operate in the long run, this need is not related to the technical thought of the invention in this application -- they are things. Therefore, in the configuration of this invention, the means indicated to be a motor generator shall include the motor which does not have a generation-of-electrical-energy function as the equal object.

[0014] In the hybrid car actuation structure like the above, said change gear may be formed in said internal combustion engine side in the middle of [section / of said second motor generator / connection] said wheel driving shaft.

[0015] Or in the hybrid car actuation structure like the above, said change gear may be formed in the side which is far apart from said internal combustion engine in the middle of [section / of said second motor generator / connection] said wheel driving shaft again.

[0016] Furthermore, in the hybrid car actuation structure like the above, said change gear may include the astern stage. In this case, hybrid car actuation structure may include further a means to perform selection between the vehicle go-astern actuation by the astern stage of said change gear, and the vehicle go-astern actuation by accommodation of said power partition system.

[0017]

[Function and Effect of the Invention] An internal combustion engine's output shaft is connected with the first motor generator and wheel driving shaft through a power partition system like the above. In the hybrid car actuation structure where the second motor generator was connected with this wheel driving shaft, if a change gear is formed at least in one side in the middle of connection of said second motor generator to this wheel driving shaft in the middle of said wheel driving shaft If it is the middle of this change gear being said wheel driving shaft and is prepared in the internal combustion engine side from the connection section of said second motor generator when high axle torque is searched for with the low vehicle speed By adjusting said power partition system, raising an internal combustion engine's rotational frequency as contrasted with the vehicle speed, and raising the reduction gear ratio of this change gear From that of the high axle torque searched for, the torque which asks catering and said

second motor generator for many with an internal combustion engine can be reduced, and this demand can be answered without things. Moreover, if prepared in the side which is the middle of this change gear being said wheel driving shaft, and is far apart from an internal combustion engine from the connection section of said second motor generator By adjusting said power partition system, raising an internal combustion engine's rotational frequency as contrasted with the vehicle speed, and raising the reduction gear ratio of this change gear A wheel is driven with this raised reduction gear ratio by having two incomes with an internal combustion engine and said second motor generator. If the torque for which the second motor generator is asked can be reduced, and this demand can be answered and this change gear is formed in the middle of connection of said second motor generator to said wheel driving shaft The wheel driving torque which accommodation of said power partition system is not [how] scrupulous, and is acquired from said second motor generator is increased by raising the reduction gear ratio of this change gear. Being able to answer this demand, maintaining a desirable balance at the relative magnitude of three persons of an internal combustion engine, the first, and the second motor generator in this way, and always operating an internal combustion engine with high fuel consumption, even if it makes said second motor generator into moderate magnitude The **** vehicle speed pair axle torque engine performance shown by the line A of drawing 3 can be obtained.

[0018] Furthermore, in the hybrid car actuation structure like the above, if it is constituted so that a change gear may include an astern stage, even if it does not adjust a power partition system on the occasion of go-astern of a vehicle, go-astern of a vehicle will be easily attained by changing a change gear to an astern stage. In this case, if a means to perform selection between the vehicle go-astern actuation by the astern stage of a change gear and the vehicle go-astern actuation by accommodation of a power partition system further is established When the vehicle go-astern by high axle torque is required like [when the ascent go-astern and driving wheel in a slope cave in to a hollow especially] When it is coped with in sufficient driving torque and the axle torque like the left is not needed like vehicle go-astern in the usual flat ground by choosing the vehicle go-astern actuation by the astern stage of a change gear The prompt go-astern without change gear change actuation can be attained by choosing the vehicle go-astern actuation by accommodation of a power partition system.

[0019] Furthermore, the above-mentioned change gear may itself already make an exaggerated drive stage well-known in various modes the highest speed gear, and can optimize operation of an internal combustion engine similarly in the conventional internal combustion locomotive with an exaggerated drive again to vehicle high-speed operation also in a hybrid car by it.

[0020]

[Embodiment of the Invention] Drawing 4 , drawing 5 , and drawing 6 are the same schematic diagrams as drawing 1 which shows three examples which build a change gear into the hybrid car actuation structure where an internal combustion engine's output shaft was connected with the first motor generator and wheel driving shaft through the power partition system as shown in drawing 1 , and the second motor generator was connected with this wheel driving shaft, by this invention. In drawing 4 , drawing 5 , and drawing 6 , the part corresponding to the part shown in drawing 1 R> 1 is shown by the corresponding sign.

[0021] In the first example shown in drawing 4 , a change gear 100 is in the middle of a wheel driving shaft, is formed in the internal combustion engine side from the connection section of the second motor generator MG 2, and if it says by **** of the explanation about drawing 1 R> 1, it is formed in the internal combustion engine side by the gearing 15 which are some propeller shafts 11 which form some wheel driving shafts, and makes the connection section of MG2. Change gears 100 may be two steps thru/or three steps of things, and may include an astern stage further. Although such a change gear is already obtained in various modes by the well-known technique, if the example is shown in solution Fig. about what has three steps of advance, and an astern stage, it will be as drawing 7 .

[0022] In drawing 7 , 20, 22, 24, and 26 are the sun gear which constitutes one epicyclic gear device, flywheel starter gear, a planetary pinion, and a carrier, and 21, 23, 25, and 27 are the sun gear which constitutes other one epicyclic gear device, flywheel starter gear, a planetary pinion, and a carrier, 28 (C1) and 29 (C2) are clutches, and 32 (F1) is [30 (B1) and 31 (B-2) are brakes, and] an one-way clutch. And these revolution elements use 33 as an input shaft, and use 34 as an output shaft. If it is together put like the graphic display between them, when a clutch C1 is engaged, the first speed gear with the largest reduction gear ratio will be attained. When a clutch C1 and a brake B1 are engaged, the second speed gear of middle is attained for a reduction gear ratio. When clutches C1 and C2 are engaged, the 3rd speed gear with the smallest (reduction gear ratio = 1) reduction gear ratio is attained, and an astern stage is attained when a clutch C2 and brake B-2 are engaged.

[0023] In the example of drawing 4 , supposing a change gear 100 gives three steps of gear changes, the capacity

property diagram of vehicle speed pair axle torque will be changed like drawing 8 as contrasted with drawing 3 in case this change gear cannot be found. In this diagram, a field B1, B-2, and B3 are the fields mainly provided by the internal combustion engine (they are an internal combustion engine and MG1 by the case) by making a change gear into the first speed gear, the second speed gear, and the 3rd speed gear, respectively, and the field C which remains is a field provided by the second motor generator MG 2. It will be understood that the maximum torque for which MG2 is asked is substantially reduced from drawing 8 as compared with the case of drawing 3 .

[0024] In the second example shown in drawing 5 , a change gear 101 is in the middle of a wheel driving shaft, and the internal combustion engine is formed in the far apart side from the connection section of the second motor generator MG 2, and if it says by **** of the explanation about drawing 1 , it is prepared in the side which is far apart from an internal combustion engine by the gearing 15 which are some propeller shafts 11 which form some wheel driving shafts, and makes the connection section of MG2. Change gears 101 may also be two steps thru/or three steps of things, and may be ******** which may include an astern stage further and is shown in drawing 7 R> 7.

[0025] In the example of drawing 5 , supposing a change gear 101 gives three steps of gear changes, the capacity property diagram of vehicle speed pair axle torque will be changed like drawing 9 as compared with drawing 3 in case this change gear cannot be found. In this diagram, field B1+C1, B-2+C2, and B3+C3 are the fields mainly provided by an internal combustion engine (they are an internal combustion engine and MG1 by the case), and MG2 by making a change gear into the first speed gear, the second speed gear, and the 3rd speed gear, respectively. Also in this case, the maximum torque for which MG2 is asked is substantially reduced as compared with the case of drawing 3 as drawing 9 shows.

[0026] In the 3rd example shown in drawing 6 , the change gear 102 is formed in the middle of connection of the second motor generator MG 2 to a wheel driving shaft, and if it says by **** of the explanation about drawing 1 , it is formed in the connection section of MG2 to the propeller shaft 11 which forms some wheel driving shafts. Change gears 102 may also be two steps thru/or three steps of things. In this case, since the change of an electrical circuit can perform inversion actuation of MG2 easily, an astern stage may not be in a change gear 102. However, you may be ******** whose change gear 102 may also be equipped with the astern stage, and shows it to drawing 7 .

[0027] In the example of drawing 6 , supposing a change gear 102 gives three steps of gear changes, the capacity property diagram of vehicle speed pair axle torque will be changed like drawing 10 as compared with drawing 3 in case this change gear cannot be found. In this diagram, Field B is a field mainly provided by the internal combustion engine (they are an internal combustion engine and MG1 by the case), and fields C1, C2, and C3 are fields provided by MG2 by making a change gear into the first speed gear, the second speed gear, and the 3rd speed gear, respectively. In drawing 10 , a field C1 shows the torque field which can be provided by adding the torque which increased the output torque of MG2 with the change gear of the first speed gear after acquiring the torque which is equivalent to Field B with an internal combustion engine. It is shown that the same is said of fields C2 and C3. The maximum torque for which MG2 self is asked is substantially reduced as compared with the case of drawing 3 as drawing 10 shows.

[0028] In addition, drawing 8 - drawing 10 are the capacity property diagrams showing the magnitude of the torque which can see by the system of coordinates of vehicle speed pair axle torque as above-mentioned, and can be provided mainly with an internal combustion engine (they are an internal combustion engine and MG1 by the case), and the second motor generator MG 2 to the vehicle speed, and are not a gear change diagram in this hybrid car actuation structure with a change gear. That is, in the example of drawing 4 and drawing 5 , it does not mean that a change gear is surely switched to the second speed gear and the 3rd speed gear from the first speed gear as the vehicle speed increases from the low vehicle speed to the high vehicle speed, also when the demand to axle torque is low. In these examples, using the field B of drawing 3 as setting a change gear as the 3rd speed gear, when it carries out and slack high axle torque is not like needed at the time of the usual vehicle start in the flat ground, when, as for the second speed gear and the first speed gear, demand axle torque increases, respectively, a shift lever may be made to be used by control of a power partition system according to being switched to two locations and L location.

[0029] Also in which above example, moreover, the thing to do for go-astern actuation a vehicle or it is seeing by drawing 2 and making Nr into a negative value and it does not require whether the internal combustion engine is operated (Nc=0) (Nc> 0) -- irrespective of -- so that the rotational frequency Nr of MG2 may become a desired negative value It is attained by adjusting the rotational frequency Nr of the rotational frequencies Ns and MG2 of MG1 according to the internal combustion engine rotational frequency Nc. Although adjustment control of this

rotational frequency of MG1 and MG2 can be stepless and can be performed promptly, since the torque which carries out go-astern actuation of the vehicle in this case can be provided only with a motor generator, the magnitude of the go-astern driving torque acquired is restricted. on the other hand, a change gear -- drawing 4 R> -- it can set in the example shown in 4 or 5 -- as -- a wheel driving shaft -- on the way -- although the change of a change gear will take that time amount a little if this is switched to an astern stage, it is alike with an internal combustion engine and it made to carry out go-astern actuation of the wheel when it is alike, it is prepared and it has the astern stage, go-astern actuation of the vehicle can be carried out in big driving torque. Then, although not shown in drawing, if a means to perform selection between the vehicle go-astern actuation by the astern stage of a change gear and the vehicle go-astern actuation by accommodation of a power partition system is established, according to the magnitude of the driving torque which vehicle go-astern actuation takes, selection between both can be performed suitably, and more suitable vehicle operation can be performed. According to the vehicle control device equipped with the present computer, a means to perform this selection is almost attained by the software target.

[0030] Although this invention was explained above about some examples at the detail, probably this invention will not be restricted only to these examples and it will be clear for this contractor for various examples to be possible otherwise within the limits of this invention.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram showing the actuation structure of the hybrid car set as the object of amelioration by this invention.
[Drawing 2] The diagram showing the relation between the rotational frequencies Nc, Ns, and Nr of the internal combustion engine and two motor generators MG1 and MG2 in the hybrid car actuation structure shown in drawing 1 .
[Drawing 3] The diagram showing the axle torque which should be shared by each of an internal combustion engine and a motor generator MG 2 in the hybrid car actuation structure shown in drawing 1 to the vehicle speed.
[Drawing 4] The schematic diagram showing the first example of the amelioration made by this invention about the hybrid car actuation structure shown in drawing 1 .
[Drawing 5] The schematic diagram showing the second example of the amelioration made by this invention about the hybrid car actuation structure shown in drawing 1 .
[Drawing 6] The schematic diagram showing the third example of the amelioration made by this invention about the hybrid car actuation structure shown in drawing 1 .
[Drawing 7] The schematic diagram showing an example of a change gear which offers three gear ratios and astern stages.
[Drawing 8] The diagram showing the axle torque which should be shared by each of an internal combustion engine and a motor generator MG 2 in the hybrid car actuation structure shown in drawing 4 to the vehicle speed.
[Drawing 9] The diagram showing the axle torque which should be shared by each of an internal combustion engine and a motor generator MG 2 in the hybrid car actuation structure shown in drawing 5 to the vehicle speed.
[Drawing 10] The diagram showing the axle torque which should be shared by each of an internal combustion engine and a motor generator MG 2 in the hybrid car actuation structure shown in drawing 6 to the vehicle speed.
[Description of Notations]
1 -- Internal combustion engine
2 -- An internal combustion engine's output shaft
3 -- Epicyclic gear drive
4 -- Sun gear
5 -- Flywheel starter gear
6 -- Planetary pinion
7 -- Carrier
8 -- The first motor generator (MG1)
9 -- Coil
10 -- Rotator
11 -- Propeller shaft
12 -- The second motor generator (MG2)
13 -- Coil
14 -- Rotator
15 16 -- Gearing
17 -- Differential equipment
18 -- Axle
19 -- Wheel
20 -- Sun gear
22 -- Flywheel starter gear

24 -- Planetary pinion
26 -- Carrier
21 -- Sun gear
23 -- Flywheel starter gear
25 -- Planetary pinion
27 -- Carrier
28 29 -- Clutch
28 29 -- Brake
32 -- One-way clutch
100,101,102 -- Change gear

[Translation done.]

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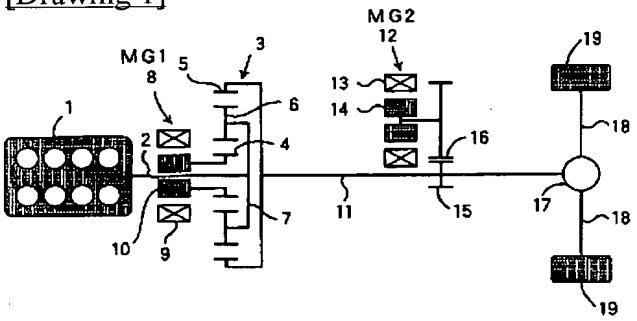
DRAWINGS

[Drawing 1]



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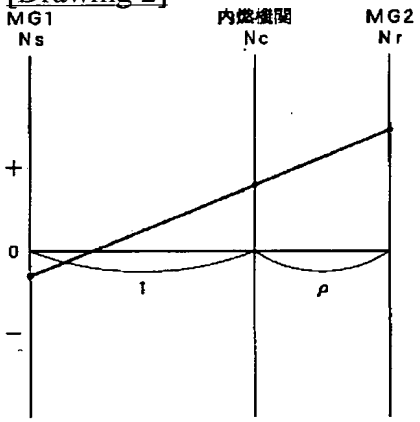

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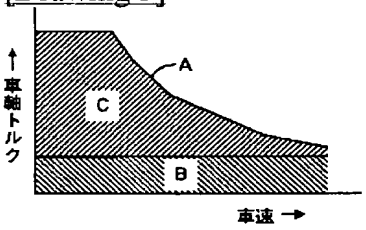
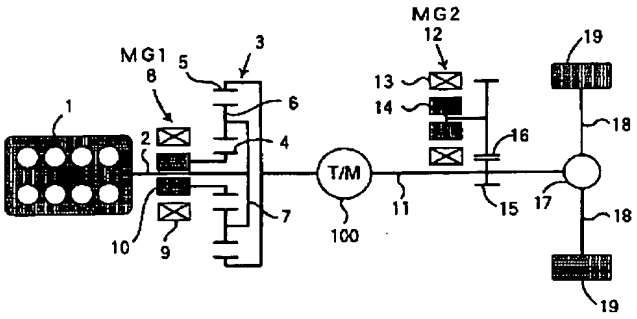
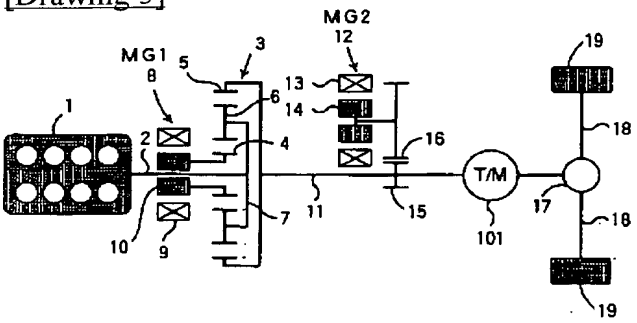


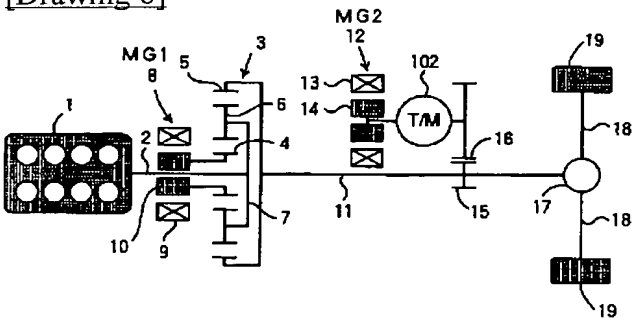
[Drawing 4]



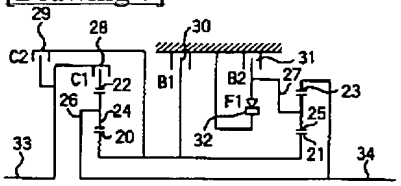
[Drawing 5]



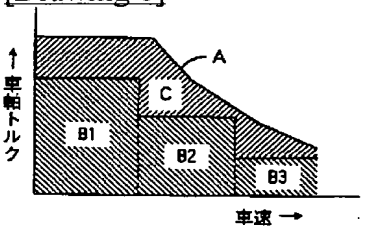
[Drawing 6]



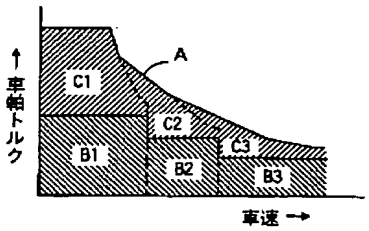
[Drawing 7]



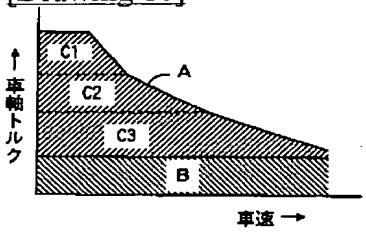
[Drawing 8]



[Drawing 9]



[Drawing 10]



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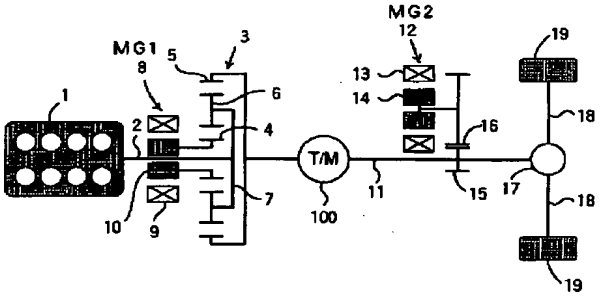
最終頁に続く

(54)【発明の名称】　変速機を備えたハイブリッド車駆動構造

(57)【要約】
【課題】　内燃機関の出力軸が動力分配機構を経て第一の電動発電機と車輪駆動軸とに連結され、該車輪駆動軸に第二の電動発電機が連結されたハイブリッド車駆動構造に於いては、内燃機関の燃費を良好に保って所要の車速対車軸トルク特性を得るためには、第二の電動発電機ＭＧ２を大型化せざるを得ない。ＭＧ２の大型化を回避して所要の車速対車軸トルク特性を得る。
【解決手段】　車輪駆動軸の途中または車輪駆動軸への第二の電動発電機の連結の途中の少なくとも一方に変速機（１００、１０１、１０２）を設ける。



たハイブリッド車駆動構造に於ける内燃機関と二つの電動発電機ＭＧ１、ＭＧ２の回転数Ｎｃ、Ｎｓ、Ｎｒの間の関係は、遊星歯車装置の原理に基づき、図２に示す線図により表される。図にてρはリングギヤの歯数に対するサンギヤの歯数である（ρ＜１）。Ｎｃは機関回転数により定まり、Ｎｒは車速により定まるので、Ｎｓは機関回転数と車速の如何により

Ｎｓ＝（１＋１／ρ）Ｎｃ－（１／ρ）Ｎｒ

として定まる。

【０００６】一方、キャリアとサンギヤとリングギヤのトルクをＴｃ、Ｔｓ、Ｔｒとすると、これらは

Ｔｓ：Ｔｃ：Ｔｒ＝ρ／（１＋ρ）：１：１／（１＋ρ）

の比にて互いに平衡し、従ってまた、これら３要素のいずれかがトルクを発生しあるいは吸収するときには、上記の平衡が成り立つまで相互間にトルクのやりとりが行なわれる。

【０００７】以上の如き駆動構造を備えたハイブリッド車に於いて、内燃機関、ＭＧ１、ＭＧ２の作動は、図には示されていない車輌運転制御装置により、運転者からの運転指令と車輌の運行状態とに基づいて制御される。即ち、車輌運転制御装置はマイクロコンピュータを備え、運転者からの運転指令と種々のセンサにより検出される車輌の運行状態とに基づいて目標車速および目標車輪駆動トルクを計算すると共に、蓄電装置の充電状態に基づいて蓄電装置に許される電流出力あるいは蓄電装置の充電のために必要な発電量を計算し、これらの計算結果に基づいて、内燃機関を休止を含む如何なる運転状態にて運転すべきか、またＭＧ１およびＭＧ２をいかなる電動状態あるいは発電状態にて運転すべきかを計算し、その計算結果に基づいて内燃機関、ＭＧ１、ＭＧ２の作動を制御する。

【０００８】

【発明が解決しようとする課題】以上の如く内燃機関の出力軸が動力分配機構を経て第一の電動発電機と車輪駆動軸とに連結され、該車輪駆動軸に第二の電動発電機が連結されたハイブリッド車駆動構造によれば、図２より理解される通り、内燃機関出力軸の回転数Ｎｃと車速に対応する回転数Ｎｒの各々の値およびその間の相対関係は、その変化を第一の電動発電機の回転数Ｎｓにて吸収することにより大幅に変えることができるので、かかるハイブリッド車駆動構造に於いては、これまで変速機は不要とされていた。即ち、動力分配機構の調節次第で、ＮｃとＮｒの間の関係を自由に変えることができ、また停車中（Ｎｒ＝０）であっても機関運転（Ｎｃ＞０）すること、逆に、前進中（Ｎｒ＞０）であっても機関停止（Ｎｃ＝０）すること、あるいは機関の運転または停止（Ｎｃ≧０）にかかわらず後進（Ｎｒ＜０）することができる。

【０００９】しかし、ＭＧ２の回転数は車速の如何によって左右され、蓄電装置の充電度は車速とは一応無関係であるため、ＭＧ２が蓄電装置の充電のための発電機として作動するには大きな制約がある。そこで蓄電装置の充電は専らＭＧ１に頼ることとなり、逆に車輪の電動駆動は専らＭＧ２に頼ることとなる。そのため変速機を備えない上記の如きハイブリッド車駆動構造に於いて、低車速領域にても必要に応じて高い車輪駆動トルクを得ることができる車輌運転性能を確保しておくためには、畢竟ＭＧ２は大型化せざるを得ない。

【００１０】これを車速に対する車軸トルクの能力特性線図で示せば、図３の通りである。即ち、今、車輌の内燃機関を広い車速域に亙って高燃費にて運転し、しかも車輌の車速対車軸トルク性能として望まれる限界性能として線Ａにて示す如き性能を車輌に持たせようとすれば、高燃費を得る内燃機関の車速対車軸トルク性能は領域Ｂの如くほぼ平らになるので、残りを専らＭＧ２にて補わなければならず、その車速対車軸トルク性能は領域Ｃを賄うものでなければならない。そのためＭＧ２は低回転速度にて高トルクを発生することができるよう、それ相当の大型のものとされなければならない。

【００１１】しかし、図３を吟味すれば、領域Ｃの深さは領域Ｂの深さに対比して些か深すぎるのではないかとの疑問がもたれる。これは、観点を変えれば、内燃機関と第一および第二の電動発電機なる三つの原動装置の大きさの相対的釣合い、特に内燃機関と第二の電動発電機の大きさの釣合いの問題である。本発明は、かかる疑問に端を発し、この点に関し上記の如きハイブリッド車輌駆動構造を更に改良することを課題としている。

【００１２】

【課題を解決するための手段】かかる課題を解決するものとして、本発明は、内燃機関の出力軸が動力分配機構を経て第一の電動発電機と車輪駆動軸とに連結され、該車輪駆動軸に第二の電動発電機が連結されたハイブリッド車駆動構造に於いて、前記車輪駆動軸の途中または該車輪駆動軸への前記第二の電動発電機の連結の途中の少なくとも一方に変速機を設けたことを特徴とするハイブリッド車駆動構造を提案するものである。

【００１３】尚、電動発電機なる語は、電動機および発電機の両機能を有する手段を指すが、本願発明は、内燃機関の出力軸が動力分配機構を経て第一の電動発電機と車輪駆動軸とに連結され、該車輪駆動軸に第二の電動発電機が連結されたハイブリッド車駆動構造の、短期的車輌駆動性能に関するものであり、換言すれば、車輌のハイブリッド駆動における内燃機関駆動と、電動駆動と、蓄電装置に対する自己充電作用の相互関係が関与する長期的車輌駆動性能に関するものではないので、本願発明の作用および効果に関する限り、第一および第二の電動発電機は、いずれも単なる電動機であってよいものである。確かに、実働する車輌駆動装置としては、既に記した通り、第二の電動発電機は専ら電動機として作動せざ

３０（Ｂ１）、３１（Ｂ２）はブレーキであり、３２（Ｆ１）はワンウェイクラッチである。そしてこれらの回転要素が、３３を入力軸とし、３４を出力軸として、その間に図示の如く組み合わされていると、クラッチＣ１が係合されることにより減速比が最も大きい第１速段が達成され、クラッチＣ１とブレーキＢ１とが係合されることにより減速比が中程の第２速段が達成され、クラッチＣ１とＣ２とが係合されることにより減速比が最も小さい（減速比＝１）第３速段が達成され、クラッチＣ２とブレーキＢ２とが係合されることにより後進段が達成される。

【００２３】図４の実施例に於いて、変速機１００が3段の変速を与えるようになっているとすると、車速対車軸トルクの能力特性線図は、かかる変速機がない場合の図３に対比して、図８の如く変更される。この線図に於いて、領域Ｂ１、Ｂ２、Ｂ３が、それぞれ変速機を第１速段、第２速段、第３速段にすることにより主として内燃機関（場合によって内燃機関およびＭＧ１）によって賄われる領域であり、残る領域Ｃが第二の電動発電機ＭＧ２によって賄われる領域である。図８より、ＭＧ２に求められる最大トルクが、図３の場合に比して大幅に低減されることが理解されよう。

【００２４】図５に示す第二の実施例に於いては、変速機１０１は車輪駆動軸の途中であって第二の電動発電機ＭＧ２の連結部より内燃機関とは隔たる側に設けられており、図１についての説明の文言でいえば、車輪駆動軸の一部をなすプロペラ軸１１の一部であってＭＧ２の連結部をなす歯車１５よりも内燃機関とは隔たる側に設けられている。変速機１０１もまた２段ないし３段のものであってよく、更に後進段を含むものであってよく、図７に示す如きものであってよい。

【００２５】図５の実施例に於いて、変速機１０１が３段の変速を与えるようになっているとすると、車速対車軸トルクの能力特性線図は、かかる変速機がない場合の図３に比して、図９の如く変更される。この線図に於いては、領域Ｂ１＋Ｃ１、Ｂ２＋Ｃ２、Ｂ３＋Ｃ３が、それぞれ変速機を第１速段、第２速段、第３速段にすることにより主として内燃機関（場合によって内燃機関およびＭＧ１）およびＭＧ２によって賄われる領域である。この場合にも、図９より分かる通り、ＭＧ２に求められる最大トルクは、図３の場合に比して大幅に低減される。

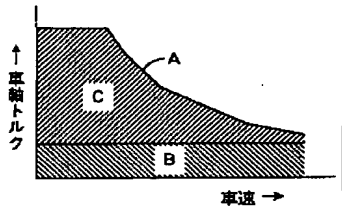
【００２６】図６に示す第３の実施例に於いては、変速機１０２は車輪駆動軸への第二の電動発電機ＭＧ２の連結の途中に設けられており、図１についての説明の文言でいえば、車輪駆動軸の一部をなすプロペラ軸１１へのＭＧ２の連結部に設けられている。変速機１０２もまた２段ないし３段のものであってよい。この場合、ＭＧ２の逆転駆動は電気回路の切換えにより簡単に行なえるので、変速機１０２には後進段はなくてもよい。しかし、変速機１０２もまた後進段を備えていてもよく、図７に示す如きものであってよい。

【００２７】図６の実施例に於いて、変速機１０２が3段の変速を与えるようになっているとすると、車速対車軸トルクの能力特性線図は、かかる変速機がない場合の図３に比して、図１０の如く変更される。この線図に於いては、領域Ｂが主として内燃機関（場合によって内燃機関およびＭＧ１）によって賄われる領域であり、領域Ｃ１、Ｃ２、Ｃ３が、それぞれ変速機を第１速段、第２速段、第３速段にすることによりＭＧ２によって賄われる領域である。図１０に於いて、領域Ｃ１は内燃機関により領域Ｂに相当するトルクを得た上でＭＧ２の出力トルクを第１速段の変速機により増大したトルクを加算することにより賄えるトルク領域を示す。領域Ｃ２、Ｃ３も同様のことを示す。図１０より分かる通り、ＭＧ２自身に求められる最大トルクは、図３の場合に比して大幅に低減される。

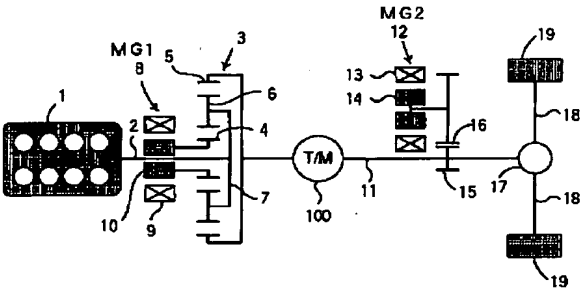
【００２８】尚、図８～図１０は、上記の通り車速対車軸トルクの座標系で見て主として内燃機関（場合によって内燃機関およびＭＧ１）および第二の電動発電機ＭＧ２により賄うことができるトルクの大きさを車速に対して示す能力特性線図であり、かかる変速機付きハイブリッド車駆動構造に於いては変速線図でない。即ち、図４および図５の実施例に於いて、車軸トルクに対する要求が低い場合にも、車速が低車速から高車速へと増大するにつれて、変速機は必ず第１速段から第２速段、第３速段へと切り換えられることを意味するものではない。これらの実施例に於いて、平地での通常の車輌発進時の如くさしたる高車軸トルクが必要とされないときには、変速機を第３速段に設定したままとして動力分配機構の制御により図３の領域Ｂを用い、第２速段、第１速段は、それぞれ要求車軸トルクが増大したときあるいはシフトレバーが２位置、Ｌ位置へ切り換えられることに応じて使用されるようにしてよい。

【００２９】また、以上のいずれの実施例においても、車輌を後進駆動することは、図２で見てＮｒを負の値にすることであり、それには内燃機関が運転されているか（Ｎｃ＞０）いないか（Ｎｃ＝０）にかかわらず、ＭＧ２の回転数Ｎｒが所望の負の値になるよう、内燃機関回転数Ｎｃに応じてＭＧ１の回転数ＮｓおよびＭＧ２の回転数Ｎｒを調整することにより達成される。かかるＭＧ１およびＭＧ２の回転数の調整制御は、無段で迅速に行なえるが、この場合、車輌を後進駆動するトルクは電動発電機のみによってしか賄えないので、得られる後進駆動トルクの大きさは限られる。これに対し、変速機が図４または５に示す実施例における如く車輪駆動軸の途中に設けられていて後進段を備えているときには、これを後進段に切り換えて内燃機関によりに車輪を後進駆動するようにすれば、変速機の切換えに幾分かの時間を要するが、大きな駆動トルクにて車輌を後進駆動することが

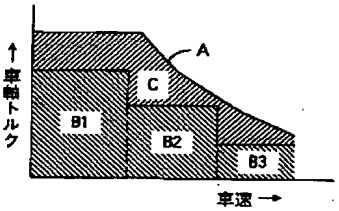
【図3】



【図4】



【図8】



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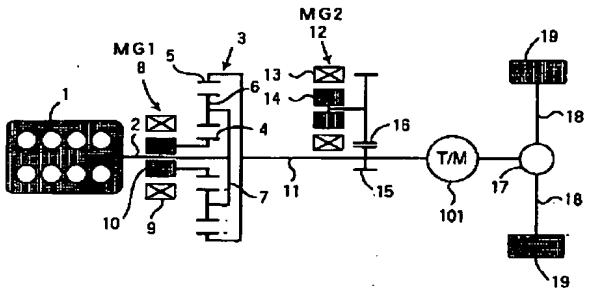
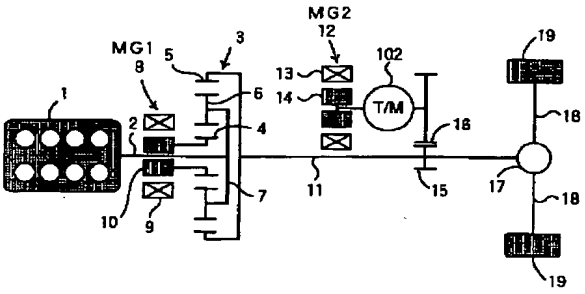
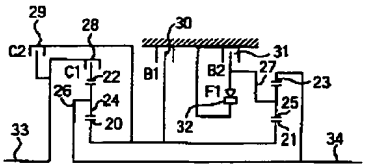


【図6】



【図7】



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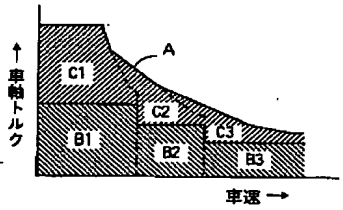
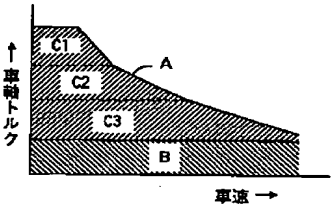


【図10】



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